

RESEARCH

Its Value to the

ART & INDUSTRY *of* HEATING-VENTILATING AIR CONDITIONING



Research Laboratory
AMERICAN SOCIETY of HEATING
and VENTILATING ENGINEERS
PHILADELPHIA

76

AMERICAN SOCIETY OF HEATING AND
VENTILATING ENGINEERS
51 MADISON AVENUE
NEW YORK, N. Y.

PRINTED IN U. S. A.

471 03880-55 H

RESEARCH

Its Value to the Art and Industry of Heating, Ventilating, Air Conditioning

BECAUSE of its direct bearing upon human life itself, and upon human achievement, the Art of Heating, Ventilating and Air Conditioning is, perhaps, more closely related to a greater number of people than any other Art, and involves scientific research of the utmost delicacy and elusiveness—Research that includes physiology as well as physics. Because of its universal application the Art also demands the most intensive development of apparatus—since this must be durable, dependable, economical and convenient.

Future Depends Upon Effective Research

IN no other Art, then, is effective Research so essential as in Heating, Ventilating and Air Conditioning. And in no other Art can Research, especially coordinated Research, augmenting individual Research, prove more profitable, of greater practical value.

These ponderable statements are fully justified by the experience of the Research Laboratory of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, working in co-operation with the United States Bureau of Mines, at Pittsburgh, Pa.

Founded in 1919—realizing the prevision of such men as J. Irvine Lyle, Fred R. Still, Homer Addams, Harry M. Hart, the A.S.H.V.E. Research Laboratory now rests firmly upon a brilliant record of achievement. Achievement which has not only contributed notably to the Science, but which has proved immeasurably profitable to the Industry and, consequently, of incalculable benefit to the Public.

Rewarding the efforts of its Founders, who gave unstintingly of their time and means, the Research Laboratory has become the leading activity of the AMERICAN SOCIETY OF HEAT-

782-1
COORCI-152 CT



THE A.S.H.V.E. RESEARCH LABORATORY AT THE U. S. BUREAU OF MINES EXPERIMENT STATION, PITTSBURGH, PA. F. C. HOUGHTEN, DIRECTOR (Standing) WITH STAFF MEMBERS, PAUL McDERMOTT, A. J. KURTZ AND J. L. BLACKSHAW.

ING AND VENTILATING ENGINEERS and a tremendously effective instrument in the advancement of the Art and the Industry.

The Society is justifiably proud that it is the only professional engineering organization which maintains and operates its own Research Laboratory.

Some of The Laboratory's outstanding accomplishments will be briefly mentioned later.

Purpose and Organization of the A.S.H.V.E. Research Laboratory

THE purpose of the Research Laboratory is to provide an adequate personnel and equipment for the conduct of pure Research, capacity or rating tests, and the determination of data germane to the scientific and practical advancement of the Art. One of the very important functions is to assist in the development of Codes and Standards. The Society's contributions in this respect have been numerous and notably valuable.

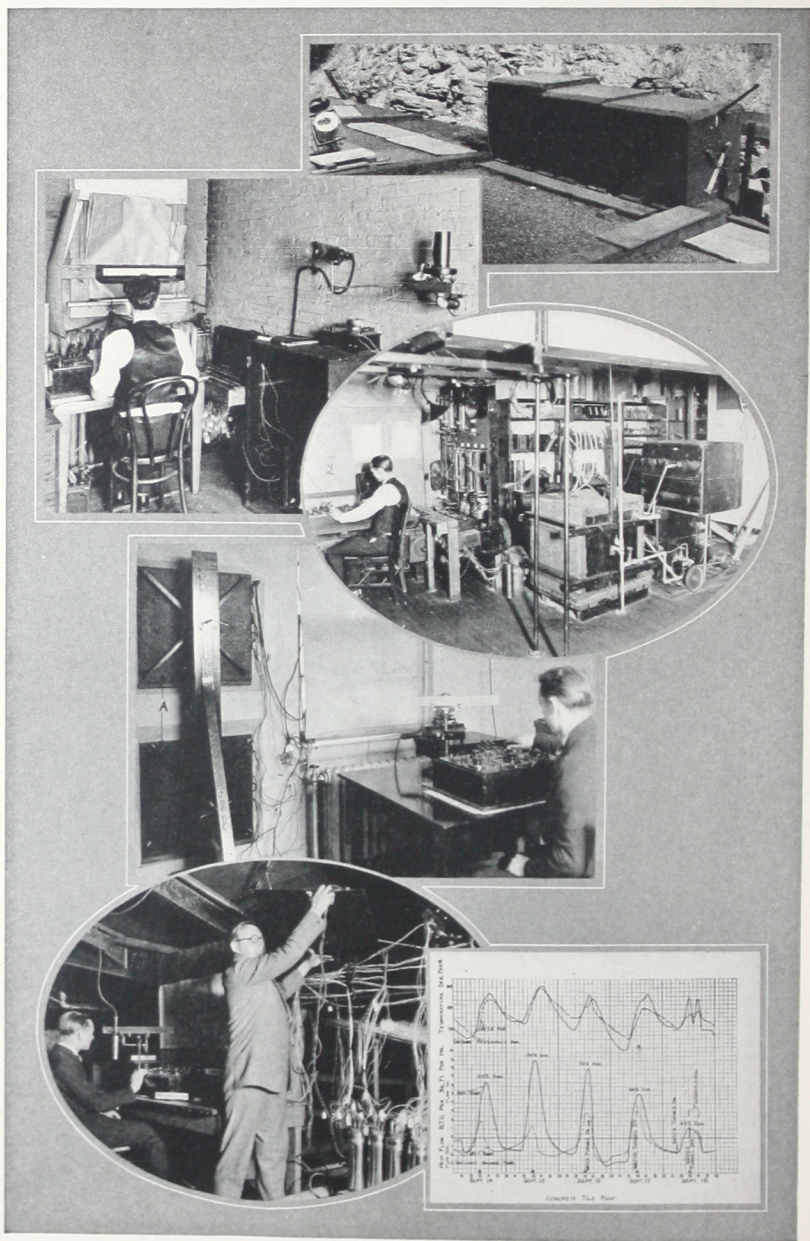
The work undertaken is determined by a Committee on Research comprising fifteen Members nominated by the Council and five elected each year for a three-year term by The Society at its Annual Meeting in January. This Committee confers with various members of the Profession and the Industry, selecting, for assignment to The Laboratory, work which appears to be most pertinent and useful.

Other Research may be undertaken for other engineering, scientific or technical organizations, or trade associations, provided all work shall be related to the Art or Science of Heating, Ventilating or Air Conditioning and of such character as to meet the approval of the Committee on Research, and that only those subjects may be investigated for which sufficient funds to pay all costs thereof have been assured.

In the conduct of specific research investigations the Committee on Research appoints Technical Advisory Committees which work with The Laboratory, in direct charge of the work, and report to the Committee on Research. *

This scheme of operation insures effective Research unbiased by commercialism, scientifically accurate and dependable,

*For those interested, the complete Regulations of the Committee on Research will be promptly forwarded by the Secretary of The Society, upon request.



SOLAR HEATING EFFECT AND HEAT FLOW THROUGH BUILDING MATERIALS MEASURED AT A.S.H.V.E. RESEARCH LABORATORY.

supervised and assisted by the most authoritative Engineers in the field, who, without remuneration, serve on the Technical Advisory Committees. In no other way could the effectiveness of the work be so fully assured.

The Laboratory is in charge of a competent, experienced Director and has an adequate staff of trained technicians. Its services are available at minimum cost because The Government furnishes, without charge, at the Bureau of Mines, space, heat, light, technical assistance and shop service.

Forty per cent of the annual dues of The Society's Members is allocated to The Laboratory, a remarkable evidence of the devotion of these men and women to the advancement of their Profession and Industry. In addition to this a major portion of the income derived from THE GUIDE, The Society's annual Reference Volume, is also apportioned to The Laboratory.

The Society thus assists one of its most beneficent activities by means of an equally beneficent activity,—since THE GUIDE is now generally acknowledged as the outstanding reference work in its field and is widely used as a text book in many of the leading Universities.

The funds of the Research Laboratory are further augmented by the contributions of various organizations and manufacturers.

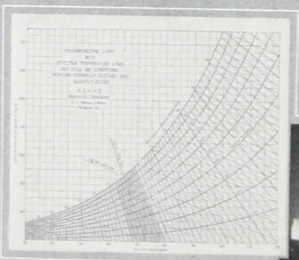
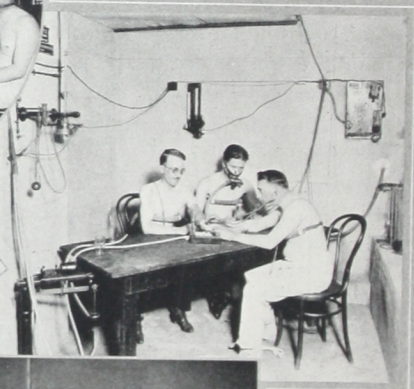
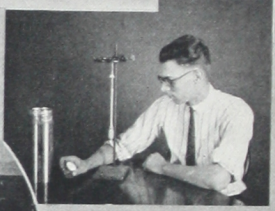
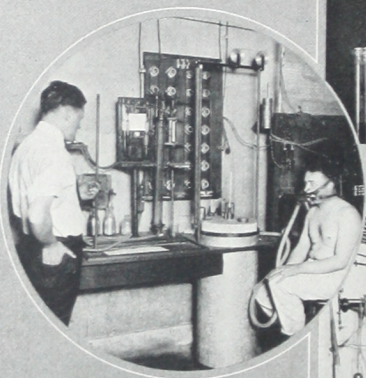
The expenditures of the Research Laboratory for its first 12 years are herewith tabulated:

1919—\$13,358.39	1925—\$17,623.82
1920— 20,225.12	1926— 26,607.49
1921— 27,664.60	1927—†35,324.83
1922—*11,863.33	1928— 32,017.90
1923— 33,235.43	1929— 33,683.15
1924— 21,519.91	1930— 40,486.26

*Fiscal year changed from August 1 to July 30 to calendar year January 1 to December 31.

†Cooperative agreements started.

For a three-year period commencing in 1931, the budget has been planned on an average expenditure of \$45,000.00, of which \$25,000.00 is expected to be contributed by the Industry. Such contributions will enable The Society not only to continue the splendid work of its Research Laboratory, but to expand it in accordance with the rapidly growing requirements of the Art and the Industry.



THE COMFORT ZONE ESTABLISHED BY THE A.S.H.V.E. IN COOPERATION WITH THE U. S. PUBLIC HEALTH SERVICE AND BUREAU OF MINES AFTER STUDYING PHYSIOLOGICAL REACTIONS TO TEMPERATURE, HUMIDITY AND AIR MOVEMENT.

Rather than permit present business conditions to curtail The Laboratory's activities The Society is determined to proceed at full effectiveness, confident that this course will prove exceedingly beneficial and profitable as business returns to normal. Funds, for the period 1931-33, will be expended, as heretofore, with the utmost care, so that the greatest possible return per dollar may be assured.

University Cooperative Agreements

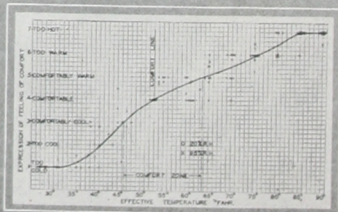
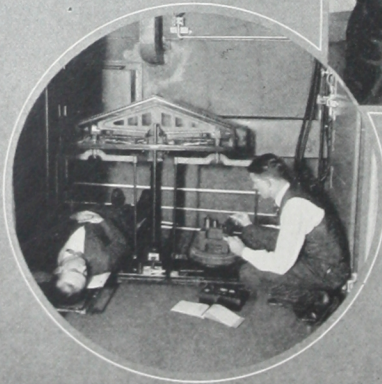
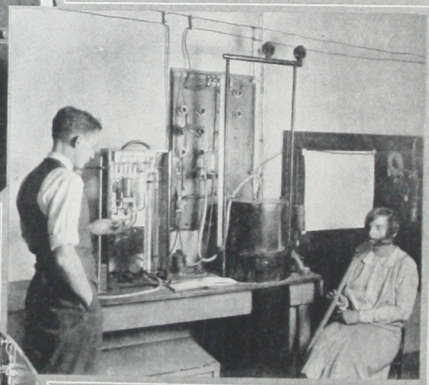
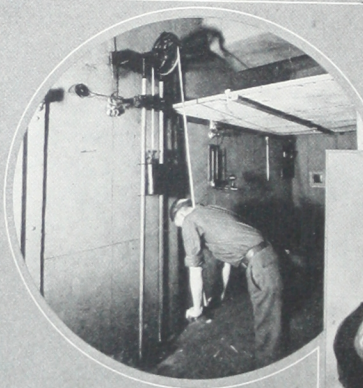
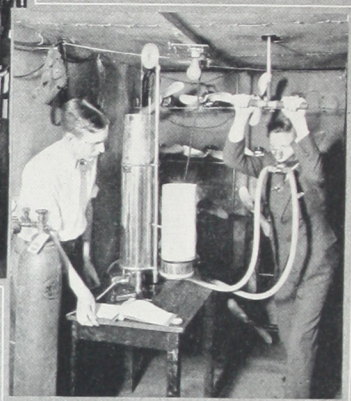
FROM the inception of The Research Laboratory the Committee on Research has sponsored cooperative investigations in Colleges, but until 1927 the program was necessarily restricted. In 1927, in order to minimize duplication of equipment and personnel, to afford instructive as well as valuable work to Student Engineers, and to enlarge the scope of facilities, The Society entered into cooperative agreements with certain Universities, where work is carried out under The Laboratory's supervision, through a qualified Instructor, detailed to this service by the University.

This arrangement has proved especially effective, greatly broadening the scope of the work undertaken, providing excellent student training and enabling the available budget to accomplish maximum results because of minimized costs.

In addition to these advantages The Research Laboratory is enabled to disseminate widely the invaluable data resulting from such cooperative Research, whereas the individual University cannot, usually, secure so wide and effective a distribution of information.

Cooperative agreements with the following Institutions are now in effect:

1. United States Bureau of Mines
2. Armour Institute of Technology
3. Carnegie Institute of Technology
4. Harvard University
5. Texas Agricultural and Mechanical College
6. University of Illinois
7. University of Minnesota
8. University of Wisconsin
9. Washington University, St. Louis
10. Yale University



HEAT AND MOISTURE LOSSES AND HUMAN EFFICIENCY OF CHILDREN AND ADULTS STUDIED UNDER VARIOUS CONDITIONS OF TEMPERATURE AND HUMIDITY AT A.S.H.V.E. RESEARCH LABORATORY.

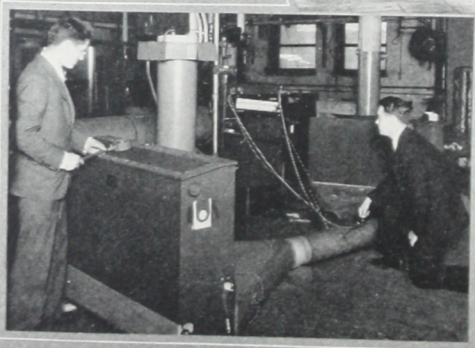
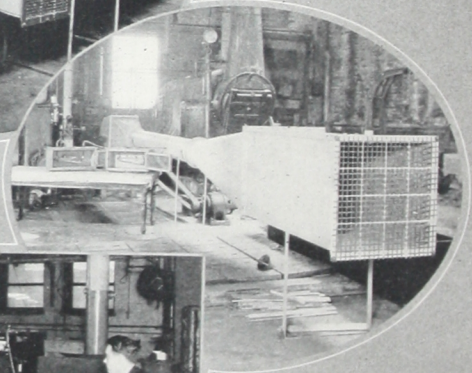
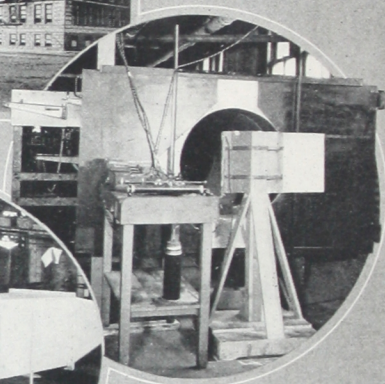
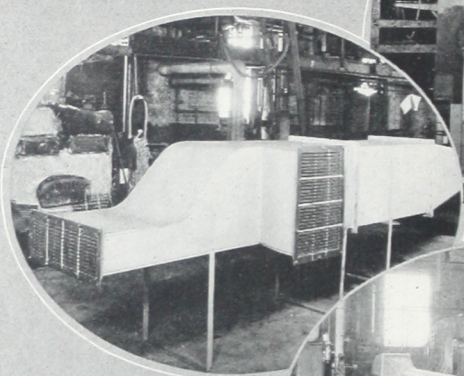
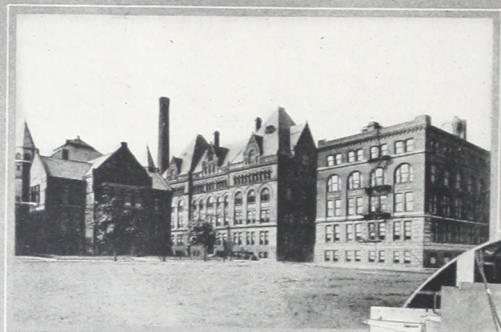
After Twelve Years Experience a Highly Potential Office is Created

EARLY in 1931, the Committee on Research, C. V. Haynes, Chairman, announced that the comprehensive experience of the preceding 12 years had made it apparent that special technical counsel and advice on various phases of the Research activities of The Society would add materially to the effectiveness of the Research Program. It was then decided to establish the Office of *Technical Adviser for Research*, and the Committee retained Arthur C. Willard, Professor of Heating and Ventilating and Head, Department of Mechanical Engineering, University of Illinois, for this post. In the first place, a competent Technical Adviser has proved tremendously useful to the Committee on Research, which is composed of men who can give but a portion of their valuable, crowded time to this philanthropic activity. In the second place, it is difficult to conceive of a more capable, suitable incumbent than Professor Willard, who has devoted himself to the Art of Heating, Ventilating and Air Conditioning for the major portion of his very active and successful career.

Engineer, Educator, Researcher, Professor Willard has contributed so importantly to Heating, Ventilating and Air Conditioning that he is honored today as one of our foremost Engineers. His counsel will prove of immeasurable value to the Research activities of The Society and The Laboratory will assuredly be enabled to function even more effectively and profitably than in the past.

Professor Willard is a Past President of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Professor of Heating and Ventilating and Head, Department of Mechanical Engineering, University of Illinois. A graduate of Massachusetts Institute of Technology, 1904, he began his teaching career in California, going to George Washington University in 1906 as Assistant Professor of Mechanical Engineering. From 1909 to 1913 he served the Government as Sanitary and Heating Engineer at the War Department, in the Office of the Chief, Q. M. C.

In 1913 he joined the Staff of the University of Illinois as Assistant Professor of Heating and Ventilating. His valuable and outstanding work in this Post won for him, in 1920, the full Professorship, which he now occupies.



MEASUREMENT OF AIR VOLUME FLOWING FROM REGISTERS, GRILLES AND UNIT VENTILATORS MADE AT ARMOUR INSTITUTE OF TECHNOLOGY BY PROF. L. E. DAVIES, UNDER COOPERATIVE AGREEMENT WITH THE A.S.H.V.E. RESEARCH LABORATORY.

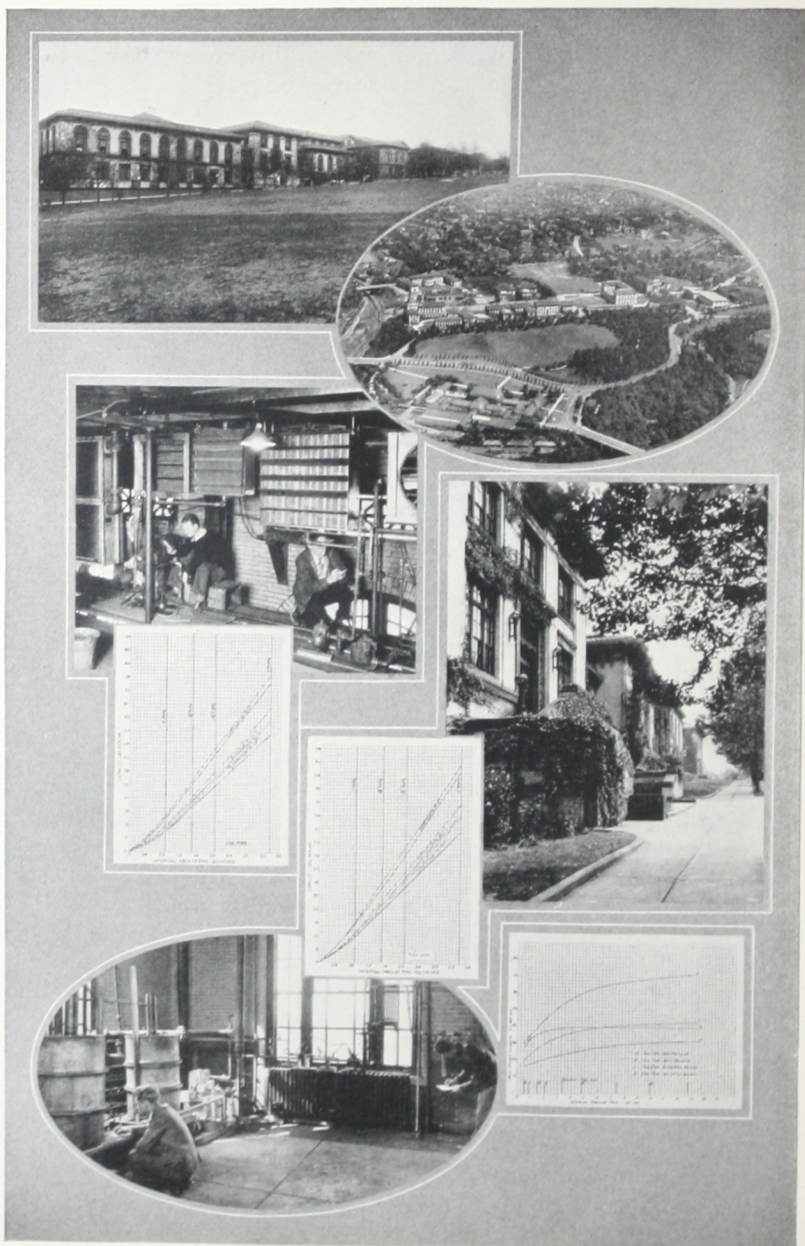
Among Professor Willard's noteworthy contributions to Heating, Ventilating and Air Conditioning are:

Studies of the heat transmission through building materials, the heat emission of steam and hot water radiators and pipes, the "heating effect" produced in rooms by all types of exposed and concealed radiators, the performance of warm-air furnaces and heating systems, the flow of air through ducts and elbows, the economical use of fuel in hand and stoker-fired boilers and furnaces, and the text *Mechanical Equipment of Buildings*, Vol. I on Heating and Ventilation, with Professor L. A. Harding as co-author.

In Research, Professor Willard is recognized as an outstanding authority. One of his best known and very useful accomplishments is his 12-year work on Warm Air Furnace Heating, for the *National Warm Air Heating Association*. His investigations conducted for the *Institute of Boiler and Radiator Manufacturers* and for the *Illinois Master Plumbers Association* have also brought him high recognition.

One of the important accomplishments in his career of public service was his work as consultant on Ventilation to the late Clifford M. Holland, Chief Engineer for the New York and New Jersey Bridge and Tunnel Commissions, responsible for the building of the \$48,000,000 Holland Vehicular Tunnels between New York and New Jersey. Professor Willard supervised most of the experimental work in connection with the ventilation methods used and the power requirements; this work being conducted principally at the University of Illinois. Since 1921 Professor Willard has been a consultant to the United States Bureau of Mines and in 1925 he became consultant to the United States War Department, Chemical Warfare Service Section, and more recently he has acted as consultant for the United States Public Health Service and the Architect of the Capitol at Washington in connection with the conditioning of the House and Senate Chambers. For the past year he has been engaged by the City of Chicago as consultant for the proposed Chicago Subway.

Thus, in retaining Professor Willard's services as Technical Adviser for Research, The Society has added another strong guaranty that the Research Laboratory will not only continue to contribute importantly to the advancement of the Art and



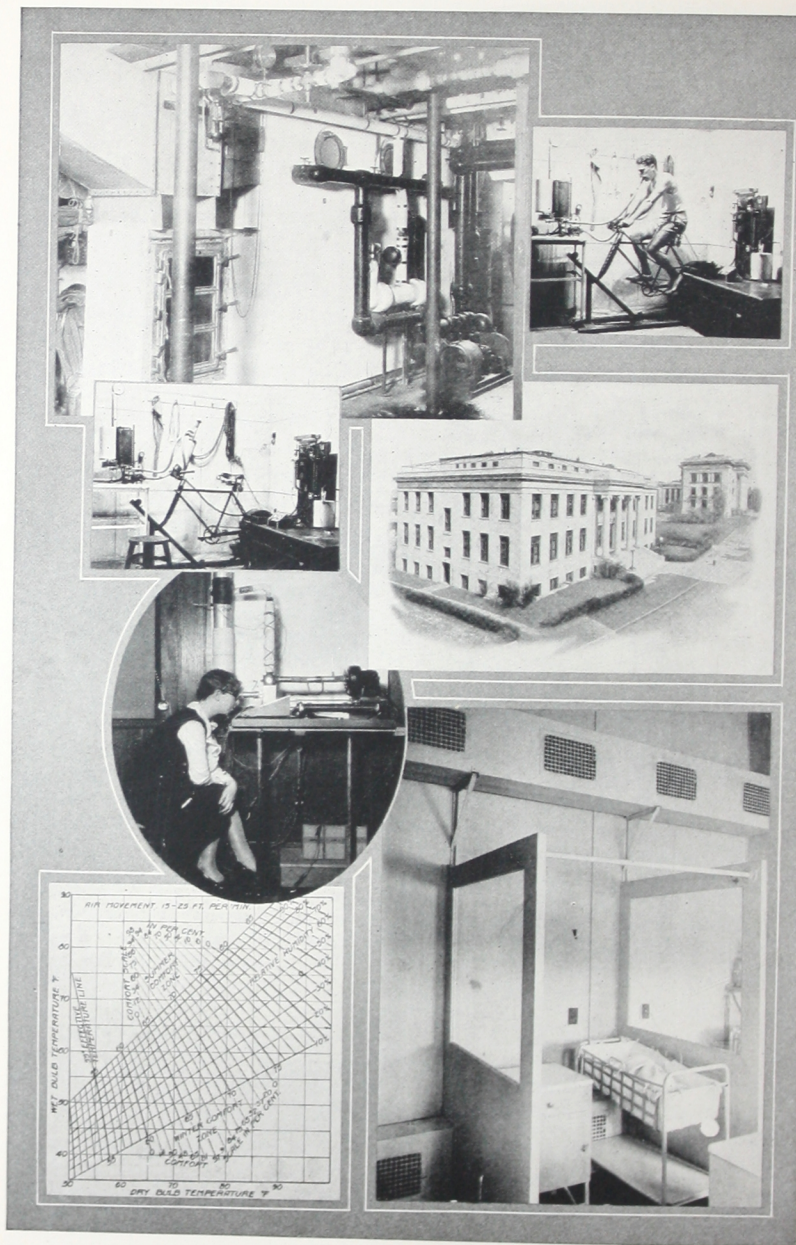
CRITICAL VELOCITIES OF STEAM FLOW AND DATA FOR STANDARD PIPING SYSTEMS FOR STEAM HEATING
DETERMINED BY A.S.H.V.E. RESEARCH LABORATORY IN COOPERATION WITH CARNEGIE INSTITUTE
OF TECHNOLOGY.

the Industry, but that such contributions will inevitably increase in both scientific and practical value, since Professor Willard's capacities have been proved as eminently practical as they are scientific.

Current Activities of the Research Laboratory

AS brief but convincing evidence of The Laboratory's scientific and practical value to the Art and Industry the following exposition of its current activities is presented. (Some of the work is being conducted at the Cooperative Institutions.)

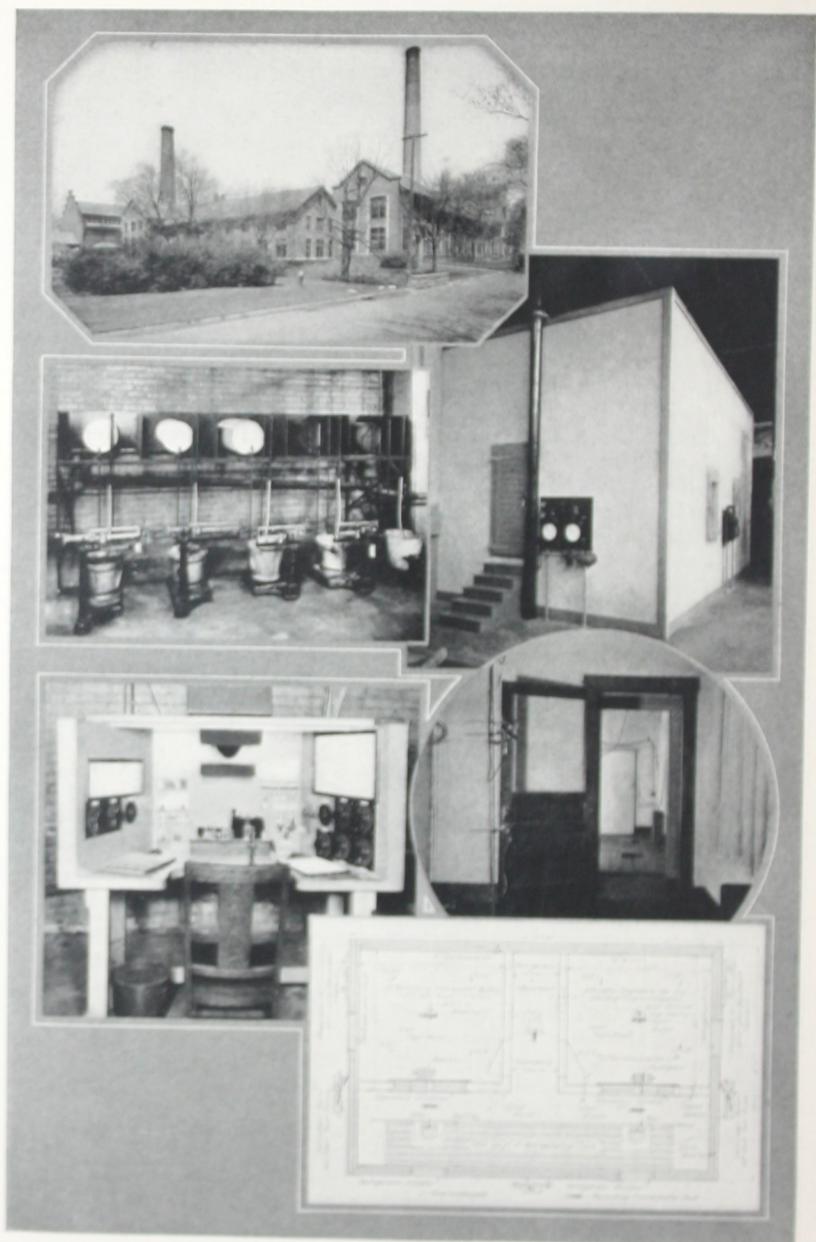
1. *Pipe Sizes for Steam and Hot Water Heating Systems.* Research on this vital subject has extended over eight years and final paper was presented in 1931. The invaluable results of this work have been made available as completed, in various Editions of THE GUIDE.
2. *Study on the Application of Copper Tubing to Steam and Hot Water Heating Systems.* Determination of steam-carrying capacity and heat emission from tubing, bare and covered.
3. *Garage Ventilation.* Study of relation of quantity of air handled, its temperature and velocity, location of supply and exhaust, and quantity of outdoor air admitted, to the concentration and distribution of carbon monoxide, gasoline vapors and other obnoxious fumes.
4. *Transmission of Heat through Building Construction and Building Materials.* Study of standard walls composed of various combinations of common materials. Verification of formula for calculating overall transfer coefficients from conductivity, air space and film conductance coefficients of component parts of a wall.
5. *Study of Methods of Evaluating the Efficiency of Air Cleaning Devices.* Continuation of other studies with object of developing standard specifications for an impinger type of instrument, for use in dust counts, which will obviate personal variations. Finally a Code for Testing Air Cleaning Devices is to be developed.
6. *Radiators and Heaters.* Study of Cast-Iron Radiators and Non-Ferrous Heaters of the "Conduction-Convection" Type, open and enclosed, under actual service conditions. Following the present trends this study will prove of signal importance.
7. *Infiltration.* Further studies of this fundamentally important subject, determining values for various walls of brick, with and without plaster, unpainted and painted, frame walls, stucco walls, including also studies of crack leakage, effectiveness of weatherstripping and general air drift across a building due to inward leakage on windward side and outward



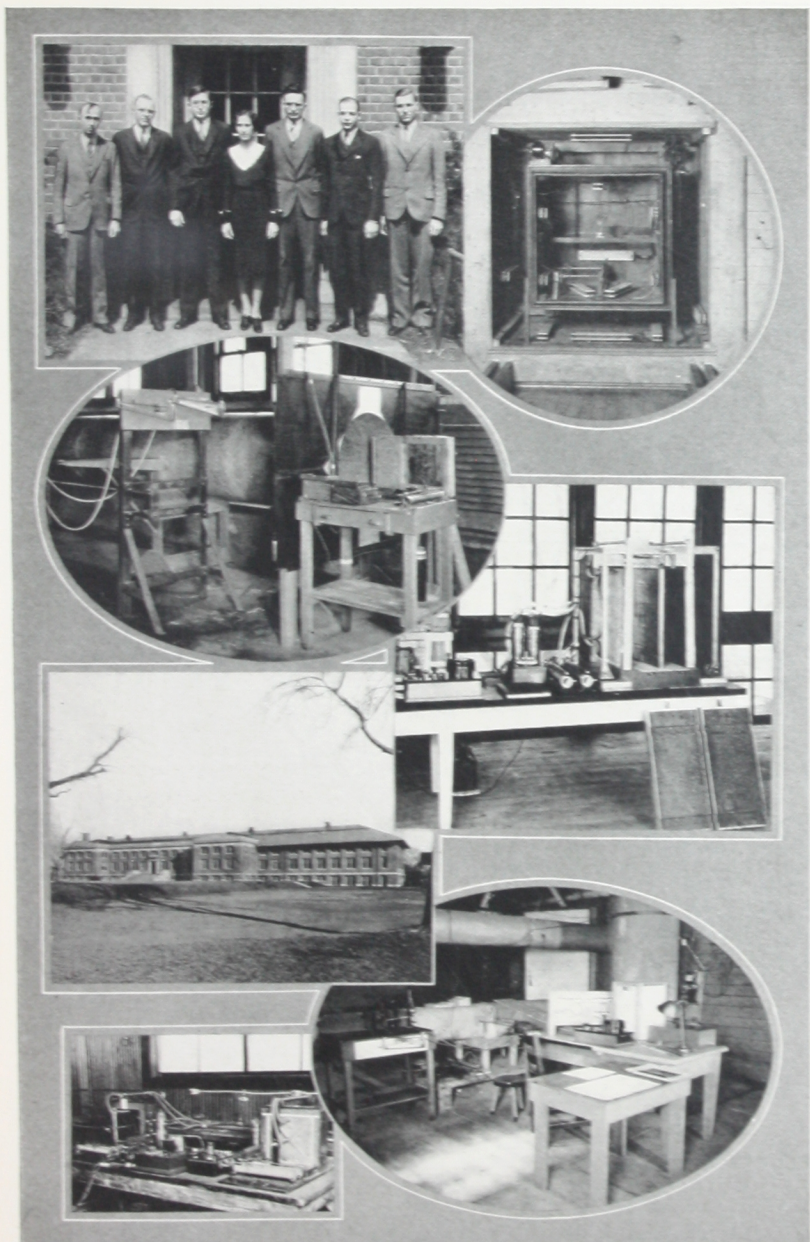
COMFORT ZONE VARIATION FOR SUMMER AND WINTER CONDITIONS REVEALED IN STUDIES OF C. P. YAGLOU
AT HARVARD SCHOOL OF PUBLIC HEALTH IN COOPERATION WITH A.S.H.V.E. RESEARCH LABORATORY.

leakage on lee side. These data will immensely increase the value of the section on Infiltration in THE GUIDE.

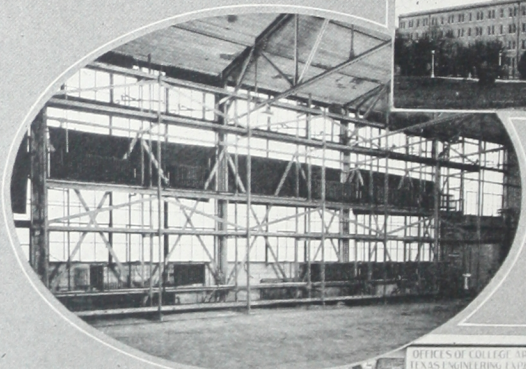
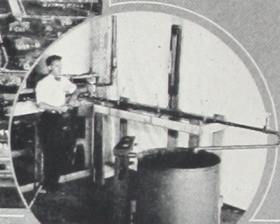
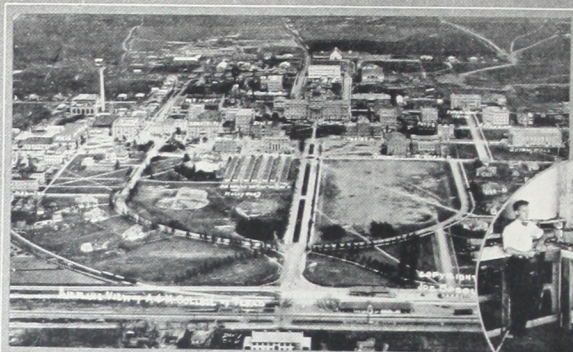
8. *Atmospheric Dust and Smoke.* A study of dust counting devices, including a special scheme for determining air dustiness by a light and electrical method developed by Dean Langsdorf of Washington University, St. Louis. This study will prove of great value, meeting, it is hoped, the pressing need for a reliable, scientific, standardized method of dust determination.
9. *Air Conditions and Their Relation to Comfort and Health.* This invaluable study was one of the original investigations undertaken by the Research Laboratory and was undertaken in cooperation with the Bureau of Mines and the U. S. Public Health Service. It will be continued as developments warrant. Dealing initially with Comfort, primarily, and resulting in one of the Society's most momentous contributions, The Comfort Charts, this study is being extended, with the cooperation of the Harvard School of Public Health, to include the even more valuable determinations relating to Human Health. Had the Research Laboratory performed no other service its contributions to this fundamentally important subject alone would have more than justified the efforts and the means which have been devoted to it.
10. *Measurement of Air Flow Through Registers and Grilles.* A study to standardize methods of measuring air flow through registers and grilles. Much needed practical data obtained, now being used by the *Ventilating Contractors Employers Association* of Chicago. Recent work has been directed toward development of satisfactory method of measuring air delivery of unit ventilating machines.
11. *Methods of Testing Oil-fired Boilers and of Rating Oil-Burning Devices.* A study to develop a most necessary standard code for testing oil burners and oil burner-boiler or-furnace combinations. The effective cooperation of the *American Oil Burner Association* insures the very great value of this undertaking.
12. *Physiological Effects of Atmospheric Environment on Human Beings at Work.* A scientific undertaking to determine the potentialities of Air Conditioning as related to the worker. The process advantages of Air Conditioning are usually more or less computable while the values accruing from the protection and invigoration of the worker, though unquestionable, have been difficultly evaluated. The objective of this tremendously valuable study is to determine these values and to fix the maximal air conditions for various circumstances.
13. *Conductivity of Concrete.* This study has been under way at The Laboratory for the past three years during which time occasional tests have been made of two slabs of concrete of different mixes to determine the effect of aging on the conductivity of the concrete. The results of this investigation should greatly increase the accuracy with which the heat losses from concrete structures may be estimated.



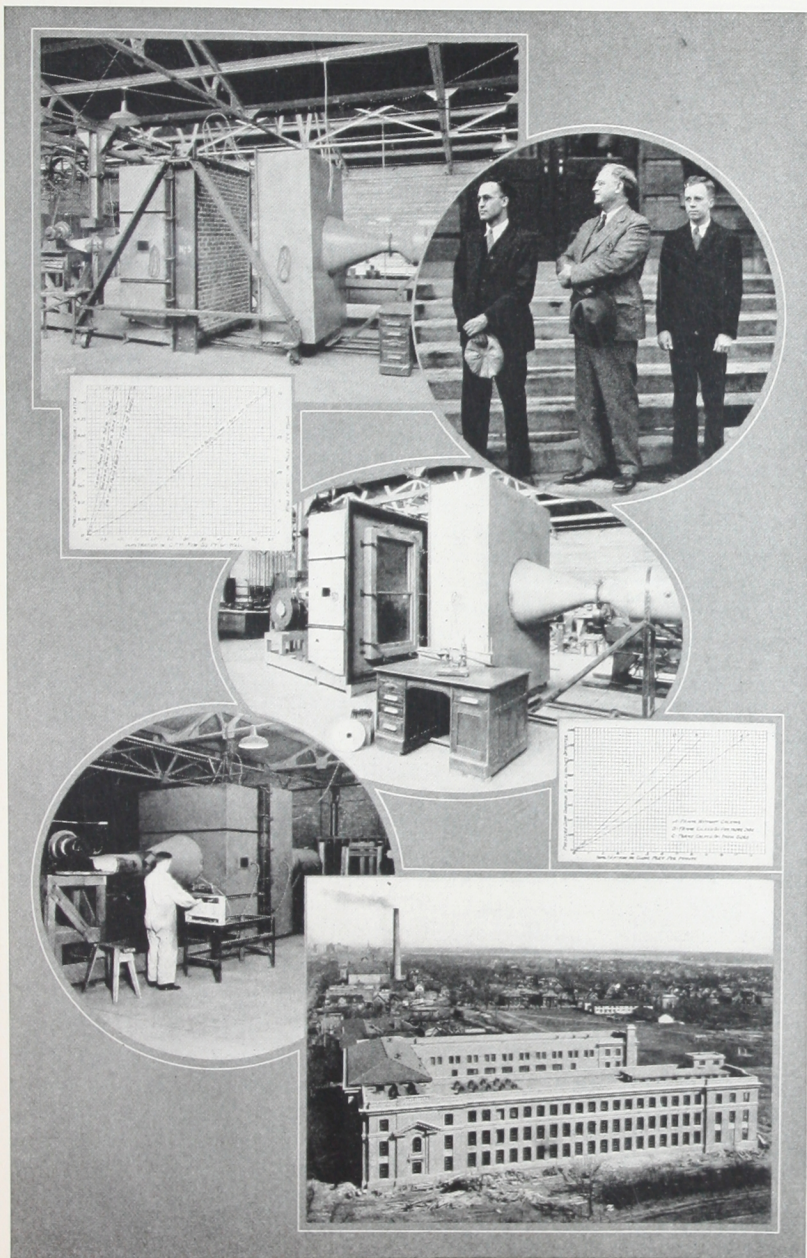
HEATING EFFECT OF RADIATORS INVESTIGATED UNDER A.S.H.V.E. RESEARCH COOPERATIVE AGREEMENT
IN SPECIAL TEST ROOMS AT ENGINEERING EXPERIMENT STATION, UNIVERSITY OF ILLINOIS, UNDER THE
DIRECTION OF PROF. A. P. KRATZ.



HOT-PLATE AND HOT-BOX APPARATUS FOR HEAT TRANSMISSION INVESTIGATIONS CONDUCTED IN COOPERATION WITH THE A.S.H.V.E. RESEARCH LABORATORY AT UNIVERSITY OF MINNESOTA, UNDER THE DIRECTION OF PROF. F. B. ROWLEY.



FLOW OF WATER THROUGH PIPE AND TUBING AND CIRCULATION IN HOT WATER HEATING SYSTEMS THE PROBLEMS OF COOPERATIVE RESEARCH BETWEEN THE A.S.H.V.E. AND A. & M. COLLEGE OF TEXAS, UNDER THE SUPERVISION OF PROF. F. E. GIESECKE.



AIR LEAKAGE THROUGH BUILDING MATERIALS, WINDOWS AND DOORS AND THE EFFECT OF WEATHERSTRIPPING DETERMINED AT THE UNIVERSITY OF WISCONSIN, UNDER THE DIRECTION OF PROF. G. L. LARSON, IN COOPERATION WITH THE A.S.H.V.E. RESEARCH LABORATORY.

14. *Effect of Heat Capacity on the Heat Penetration of the Structure.*

The purpose of this investigation is to supply information relative to the effect of heat capacity of building construction on the maximum heating and cooling loads of the building. The greater the heat capacity of the structure, the greater the difference between the maximum calculated rate of heat transfer and the measured rate. There is always a considerable lag in the rate of heat penetration through a massive wall or roof and this lag increases with the heat capacity. The work so far carried on permits only a qualitative statement of these magnitudes. However, the additional work contemplated will probably make it possible to calculate the maximum heating load in winter, or cooling load in summer for walls and roofs of various heat capacities and coefficients of transmission.

15. *Absorption of Solar Radiation by a Wall or Roof Surface.*

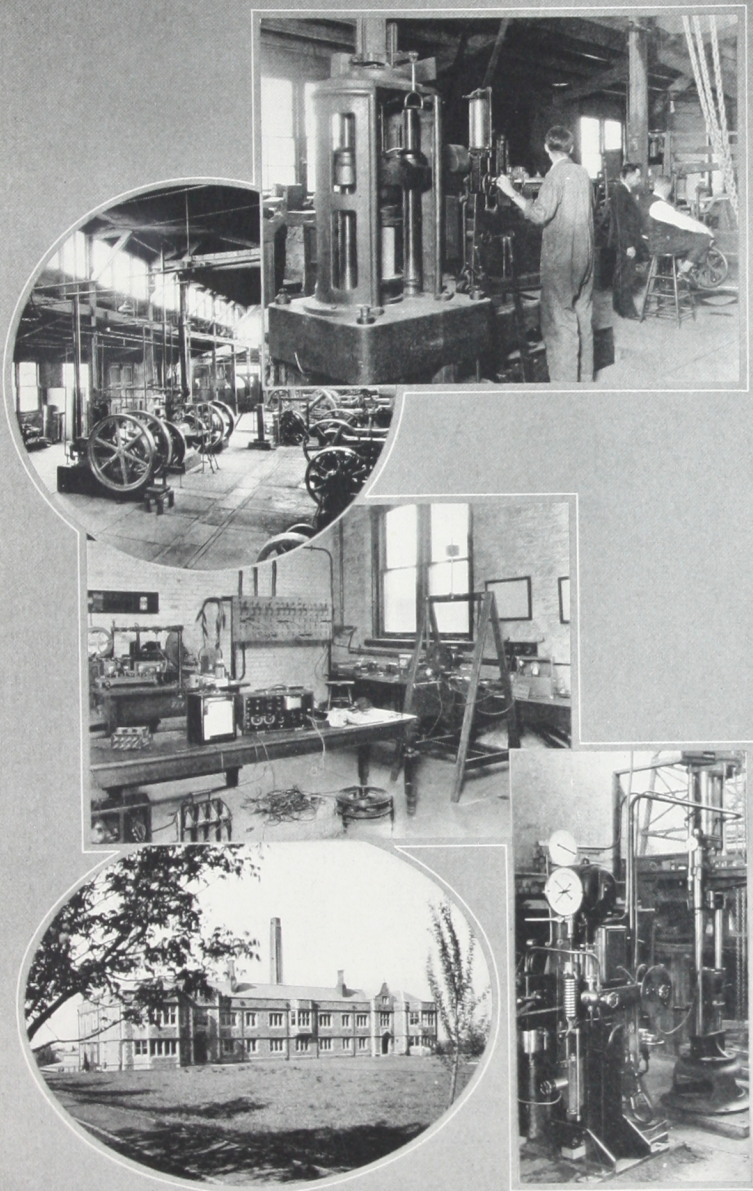
For several years the Laboratory has been accumulating data on the effect of solar radiation on heat penetration into a building during the summer. This information is of vital importance to the Air Conditioning Engineer. The early work on this subject gave information on the heat penetration through the lower surface of a roof or inner surface of a wall during warm summer days, and the variation in this rate of penetration throughout the 24-hour cycle. Early in 1930, the Laboratory presented data on the rate of heat absorption by the outside surface of a roof or wall depending upon the temperature and character of the surface, its angle with the direction of the sun's rays and other factors including data on the absorption of heat from solar rays by a plate of glass through which the sun shines. More recently The Laboratory undertook a study of both the absorption of heat at the outside surface and its penetration through three roof panels for certain hot, sunny days in July, August and September.

16. *Sound in Relation to Heating and Ventilation.*

The study has for its purpose the development of facts concerning noises resulting from heating and ventilating devices and methods of detecting, measuring and locating the source of them.

This brief summary of The Laboratory's current activities reveals the basic scientific and practical value of its work—a value which is wholly beyond computation and which will increase manyfold as the Art and the Industry progress.

Each of the undertakings enumerated is being prosecuted under the direction of a special Technical Advisory Committee, appointed by the Committee on Research, and comprising the foremost Engineers in the given field. These men serve without remuneration, giving of their time and knowledge through pure devotion to their Art and Industry. Thus the coordinated Research of the A.S.H.V.E. Laboratory is enabled to accomplish results entirely beyond the scope of any individual or corporate efforts,—augmenting such work in the most effective manner conceivable.



INSTRUMENTS FOR MEASURING THE CLEANLINESS OF AIR DEVELOPED IN COOPERATIVE WORK WITH THE A.S.H.V.E. RESEARCH LABORATORY, WASHINGTON UNIVERSITY, DEAN A. S. LANGSDORF IN CHARGE.

Future Activities of the Research Laboratory

THE future activities of the Research Laboratory are being determined by canvass of the Profession and the Industry, by means of questionnaires sent to Engineers, Architects, Manufacturers and others, by the Committee on Research.

No effort will be spared to determine the subjects of greatest interest and value. The conduct of The Laboratory will be governed accordingly. Thus it is believed that the services of The Laboratory and, coincidentally, of THE GUIDE, will be continually enhanced and extended,—to the greatest benefit of the Science, the Profession and the Industry of Heating, Ventilating and Air Conditioning.

The Inspiring History of The Laboratory

THE history of the Research Laboratory of the A.S.H.V.E. is illuminated by the devotion of many individual Members, who served specifically, and of the whole Membership, which unanimously and whole-heartedly supported the proposed program from the very beginning—in the light of The Society's then restricted Membership, a truly ambitious undertaking.

The first thoughts of pure Research, conducted by The Society on a basis wholly untrammelled by commercialism, seeking only to serve effectively and advantageously, were expressed by unrecorded Members sometime prior to 1916. It is probable that Arthur K. Ohmes' description of a Laboratory maintained by a German Technical Society first spurred the thought in our own Society. During the Presidency of H. M. Hart, 1916, the idea began to crystallize.

Certain it is that by 1917 The Society was generally discussing the subject and considering the establishment of such a Laboratory.

One of the most indefatigable workers was J. Irvine Lyle. In 1918 Mr. Lyle became President of The Society and at once pushed forward the Research Laboratory project.

He appointed the following Committee which made the initial survey and rendered a favorable report:

GEORGE W. BARR, *Chairman*

H. M. HART

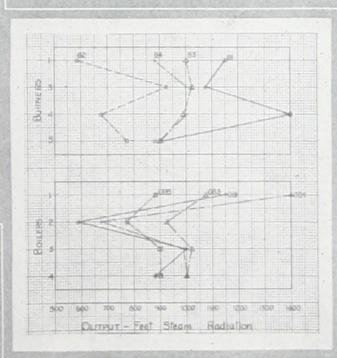
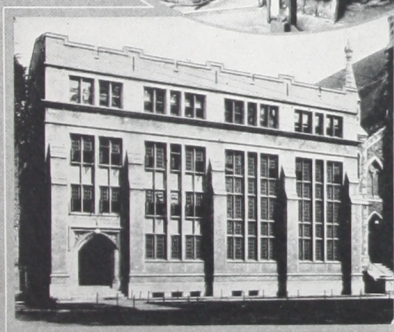
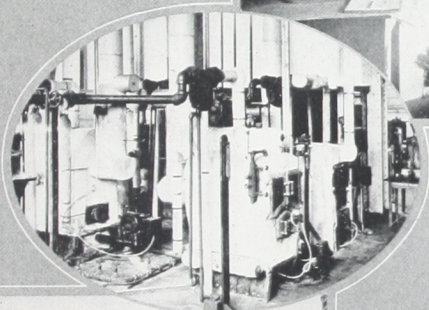
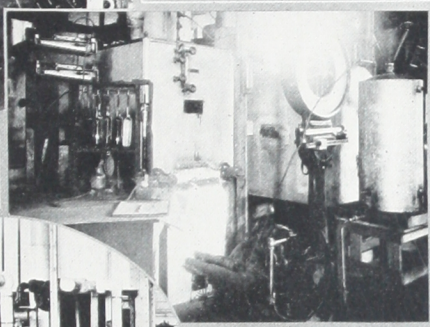
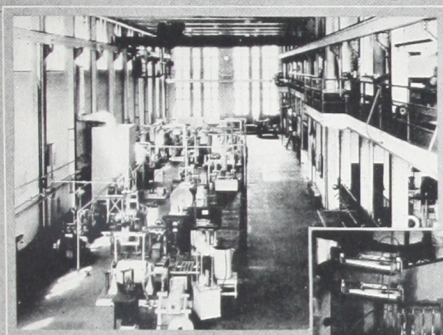
W. W. MACON

WM. F. McDONALD

J. W. H. MYRICK

PERRY WEST

Following this report the task of realizing The Society's great ambition was undertaken in earnest. Throughout the



OIL BURNER AND BOILER EFFICIENCIES UNDER VARIOUS OPERATING CONDITIONS FOUND IN COOPERATIVE TESTS CONDUCTED AT YALE UNIVERSITY, BY PROF. L. E. SEELEY IN COOPERATION WITH THE A.S.H.V.E. RESEARCH LABORATORY.

Presidency of J. Irvine Lyle and through that of Fred R. Still, ensuing, the whole Membership aided enthusiastically in the project, but the devoted, selfless work of Perry West, H. M. Hart, J. R. McColl, J. Irvine Lyle, Fred R. Still, Homer Addams, Walter S. Timmis and Frank Chew must stand forever to the glowing prestige of The Society and to the credit of the men themselves.

Despite every difficulty these men organized The Laboratory, enthused the Membership and procured the necessary funds, themselves contributing generously.

Others, of course, contributed materially. At the 25th Annual Meeting, January 1919, during the Presidency of Fred R. Still, J. Irvine Lyle put the following motion:

I should like to ask this Society to pass a vote of thanks to President Still, Vice-President Timmis, Secretary Obert, Treasurer Addams, W. F. McDonald, E. E. McNair, J. H. Davis, Dr. M. W. Franklin, and H. M. Hart, for the trips which they made at their own expense to address various Chapters on this subject.

I would like that vote of thanks also to include the following chairmen who have shown a good deal of energy in carrying on this work in their various localities: Prof. F. E. Giesecke, F. F. Bahnson, A. S. Kellogg, H. M. Hart, Prof. J. D. Hoffman, G. B. Larimer, W. F. McDonald, Prof. J. R. Allen, Mr. Chaffee, L. W. Moon, Arthur Ritter, E. T. Murphy, Prof. S. E. Dibble, C. A. Booth, and T. F. Humphreys.

PROF. JOHN R. ALLEN: I will amend the motion by adding the name of Mr. Lyle.

PRESIDENT STILL: If there is no objection that will be allowed.

The motion was seconded, and carried enthusiastically.

On August 1, 1919, during the Presidency of Walter S. Timmis, the Research Laboratory was officially established and began to function.

The first Director of The Laboratory was Dean of Mechanical Engineering, University of Michigan and of Engineering and Architecture, University of Minnesota, John R. Allen,—brilliant, self-effacing, a true scientist.

The mounting success of The Laboratory, unique among purely philanthropic undertakings, was marred by the untimely death of Dean Allen, October 26, 1920, while he was Director. But before this tragedy, the Research Laboratory, under Dean Allen's able direction, had contributed so signally to the Art and the Industry that its future was assured, as a perpetual monu-



L. A. SIPIO

F. C. HOUGHTEN

JOHN R. ALLEN

F. PAUL ANDERSON
A. C. WILLARD

ment to his devotion and ability,—a conception wholly acceptable to The Society which was honored by his membership.

The succeeding Director of The Laboratory was Dean L. A. Scipio of Robert College, Constantinople, who served during the ensuing year and then, upon termination of his leave of absence, returned to Constantinople.

On August 1, 1921, the Directorship of The Laboratory was assumed by F. Paul Anderson, Dean of the Colleges of Engineering, University of Kentucky, who rendered distinguished service in expanding The Laboratory's work and prestige, until September 1925, when the Directorship was conferred upon F. C. Houghten, then serving as Secretary of The Society.

Mr. Houghten is eminently fitted for the position as he had served under all of the Directors of the Research Laboratory, having been appointed by Dean Allen in 1920 after two years service with the United States Bureau of Mines.

From 1920 to 1924, at The Laboratory, the problems on which Mr. Houghten did active work included heat transmission through building materials; flow of steam in pipes; the use of ozone; and the effect of temperature, humidity and air motion on human beings. Since 1925 the scope of his work has enlarged and many additional projects have come under his supervision.

Prior to his entrance into research work, Mr. Houghten had a thorough engineering training, having been graduated from Olivet College in 1913, with an A.B. degree and, in 1915, receiving a Master of Science Degree from the University of Washington.

Mr. Houghten has proved an exceptionally capable Director, the work of The Laboratory having progressed notably under his leadership because of his excellent qualifications and training in engineering research and his knowledge of the needs of the heating and ventilating Profession and Industry.





CHAIRMEN COMMITTEE ON RESEARCH, A.S.H.V.E., 1917-1931

GEORGE W. BARR, 1917	J. IRVINE LYLE, 1918-19	PERRY WEST, 1917
F. R. STILL, 1920	J. R. MCCOLL, 1921	
THORNTON LEWIS, 1922	C. V. HAYNES, 1931	E. E. MCNAIR, 1923
W. H. DRISCOLL, 1924-25	H. P. GANT, 1926	
S. R. LEWIS, 1927-28	L. A. HARDING, 1929	F. B. ROWLEY, 1930

The Research Laboratory and THE GUIDE

Determination and Dissemination of Information

IN 1922, despite the relative fewness of its Membership and the meagerness of its means, The Society established THE GUIDE, an annual publication making available to the whole Profession and Industry, whether Members or not, all of the essential data collected by The Society and developed by the Research Laboratory.

Steadily, through the succeeding years, THE GUIDE has grown in size, in service and in importance. The 9th Edition in 1931 contains 924 pages of authoritative, invaluable data pertaining to the design and specification of Heating, Ventilating and Air Conditioning Systems, the practice of the leading Engineers in the field, and a comprehensive Section on available Modern Equipment.

THE GUIDE exerts, today, one of the most positive influences tending to elevate, improve, extend the whole Art and Industry of Heating, Ventilating and Air Conditioning. It is universally recognized as the most useful and authoritative work in its field, being used by practicing Engineers and Manufacturers in all parts of the world and as a Text Book by a growing number of the world's principal technical institutions.

THE GUIDE is The Society's ambassador-of-service and now has 11,000 friends who depend upon it annually for authoritative, up-to-date information on all phases of heating, ventilating and air conditioning practice.

Without detracting in any measure from the credit due many Members of The Society who have ably served, without reward, in the preparation of the annual editions of THE GUIDE, it is a matter of great pride to The Society in general that at least one-third of THE GUIDE's contents is contributed directly by the Research Laboratory. This is pointedly indicative of The Laboratory's importance and it reveals also the most pregnant fact that The Society has developed, in addition to an effective means of *determining* vital data, an equally effective means for *disseminating* it, so that it may extend its usefulness to the full.

Publications of A.S.H.V.E. Research Laboratory

In Cooperation with U. S. Bureau of Mines

BOILERS

Chimneys for House Heating Boilers

L. A. Scipio. JOURNAL, A.S.H.V.E., May, 1921
p. 463.

Heat Transference and Combustion Test in Small Domestic Boilers

John Blizard, W. M. Myler, J. K. Seabright and
C. P. Vagloglou. TRANSACTIONS, A.S.H.V.E.,
Vol. 29, 1923, p. 253.

Heat Transference and Combustion Tests in a Small Domestic Boiler

H. W. Brooks, M. L. Orr, W. M. Myler and
C. A. Herbert. TRANSACTIONS, A.S.H.V.E., Vol.
31, 1925, p. 185.

COAL STOVES

Tests to Determine the Efficiency of Coal Stoves

John R. Allen and F. B. Rowley. TRANSACTIONS,
A.S.H.V.E., Vol. 26, 1920, p. 115.

DUST*

Theory of Dust Action

O. W. Armspach. TRANSACTIONS, A.S.H.V.E.,
Vol. 27, 1921, p. 83.

Standard Method of Testing Dust Removal Efficiencies of Air Washers

Margaret Ingels and O. W. Armspach

WITH

A New Method of Making Air Dust Determinations

F. Paul Anderson and O. W. Armspach. TRANSACTIONS, A.S.H.V.E., Vol. 28, 1922, p. 221.

New Data on Air Dust Determinations

Margaret Ingels. TRANSACTIONS, A.S.H.V.E.,
Vol. 29, 1923, p. 177.

Further Observations in Dust Determinations

Margaret Ingels. TRANSACTIONS, A.S.H.V.E.,
Vol. 29, 1923, p. 347.

The Production and Measurement of Air Dustiness

Margaret Ingels. TRANSACTIONS, A.S.H.V.E.,
Vol. 30, 1924, p. 121.

The A—A Dust Determinator

Margaret Ingels. TRANSACTIONS, A.S.H.V.E.,
Vol. 31, 1925, p. 67.

How Dusty is Air?

Margaret Ingels. TRANSACTIONS, A.S.H.V.E.,
Vol. 31, 1925, p. 273.

HEAT TRANSMISSION*

Heat Transmission Through Building Materials and Heat Loss from Buildings

L. A. Scipio. JOURNAL, A.S.H.V.E., April, 1921,
p. 297.

Heat Transmission Investigations

L. A. Scipio. JOURNAL, A.S.H.V.E., May, 1921,
p. 453.

A New Thermal Testing Plate for Conduction and Surface Transmission

F. C. Houghton and A. J. Wood. TRANSACTIONS,
A.S.H.V.E., Vol. 27, 1921, p. 385.

Heat Loss Through Various Types of Building Construction

L. A. Scipio. JOURNAL, A.S.H.V.E., September,
1921, p. 637.

A Study in Heat Transmission with Special Reference to Building Materials

F. C. Houghton. TRANSACTIONS, A.S.H.V.E.,
Vol. 28, 1922, p. 81.

The Economic Thickness of Insulation in the Refrigerating Field

P. Nicholls. JOURNAL, A.S.H.V.E., April, 1922,
p. 343.

Heat Transmission Investigation

P. Nicholls. JOURNAL, A.S.H.V.E., May, 1922,
p. 449.

The Derivation of True Thermal Conductivity Coefficient from Over-all Test Results

P. Nicholls. TRANSACTIONS, A.S.H.V.E., Vol.
28, 1922, p. 325.

Measuring Heat Transmission in Building Structures and a Heat Transmission Meter

P. Nicholls. TRANSACTIONS, A.S.H.V.E., Vol.
30, 1924, p. 65.

Practical Application of the Heat Flow Meter

P. Nicholls. TRANSACTIONS, A.S.H.V.E., Vol.
30, 1924, p. 289.

Report on Heat Flow Through a Roof by Research Laboratory

Carl Zobel. TRANSACTIONS, A.S.H.V.E., Vol.
33, 1927, p. 359.

Coefficients of Heat Transfer as Measured Under Natural Weather Conditions

F. C. Houghton and C. G. F. Zobel. TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 397.

Heat Transfer Through a Roof Under Summer Conditions

F. C. Houghton and C. G. F. Zobel. TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 415.

Additional Coefficients of Heat Transfer as Measured Under Natural Weather Conditions

F. C. Houghton, Carl Gutberlet and C. G. F. Zobel. TRANSACTIONS, A.S.H.V.E., Vol. 35,
1929, p. 151.

Absorption of Solar Radiation in Its Relation to the Temperature, Color, Angle and Other Characteristics of the Absorbing Surface

F. C. Houghton and Carl Gutberlet. JOURNAL, A.S.H.V.E. (Heating, Piping and Air Conditioning), December, 1929, p. 677.

Wind Velocity Gradients Near a Surface and Their Effect on Film Conductance

F. C. Houghton and Paul McDermott. JOURNAL, A.S.H.V.E. (Heating, Piping and Air Conditioning), March, 1931, p. 229.

Conductivity of Concrete

F. C. Houghton and Carl Gutberlet. JOURNAL, A.S.H.V.E. (Heating, Piping and Air Conditioning), September, 1931.

INFILTRATION*

A Study of Infiltration of Air in Buildings

O. W. Armspach. TRANSACTIONS, A.S.H.V.E.,
Vol. 27, 1921, p. 212.

*See additional papers on this subject listed in Publications of A.S.H.V.E. Research Laboratory and Cooperating Institutions.

- A Study of the Infiltration of Air in Buildings
F. Paul Anderson. JOURNAL, A.S.H.V.E., September, 1921, p. 671.
- Air Leakage Through the Openings in Buildings
F. C. Houghten and C. C. Schrader. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 105.
- Air Leakage Around Window Openings
C. C. Schrader. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 313.
- Further Data on Infiltration
C. C. Schrader. TRANSACTIONS, A.S.H.V.E., Vol. 31, 1925, p. 85.
- Infiltration Through Plastered and Unplastered Brick Walls
F. C. Houghten and Margaret Ingels. TRANSACTIONS, A.S.H.V.E., Vol. 33, 1927, p. 377.
- Air Leakage Studies on Metal Windows in a Modern Office Building
F. C. Houghten and M. E. O'Connell. TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 321.
- Air Leakage Through a Pivoted Metal Window
F. C. Houghten and M. E. O'Connell. TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 519.
- Air Leakage Through Various Forms of Building Construction
F. C. Houghten, Carl Gutberlet and C. A. Herbert. JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), December, 1930, p. 1044.

OZONE

- Oxides of Nitrogen Produced by Ozone Apparatus
G. W. Jones, W. P. Yant and O. W. Armspach. TRANSACTIONS, A.S.H.V.E., Vol. 28, 1922, p. 121.
- A Field Method of Determination of Ozone
W. P. Yant, G. W. Jones and F. C. Houghten. TRANSACTIONS, A.S.H.V.E., Vol. 29, 1923, p. 331.

PIPES

- Theory of Heat Losses from Pipes Buried in the Ground
John R. Allen. TRANSACTIONS, A.S.H.V.E., Vol. 26, 1920, p. 335.

RADIATION*

- Heat Losses from Direct Radiation
John R. Allen. TRANSACTIONS, A.S.H.V.E., Vol. 26, 1920, p. 11.
- Determination of Radiant Heat Given Off by a Direct Radiator
John R. Allen and F. B. Rowley. TRANSACTIONS, A.S.H.V.E., Vol. 26, 1920, p. 27.
- Direct Radiation Tables
F. Paul Anderson, F. C. Houghten and Louis Ebin. JOURNAL, A.S.H.V.E., December, 1921, p. 845.
- Proposed Methods for Testing Radiators
F. C. Houghten and S. R. Lewis. TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 75.

SCHOOL ROOM VENTILATION

- Ventilation Tests of School Rooms at Minneapolis
L. A. Scipio. TRANSACTIONS, A.S.H.V.E., Vol. 27, 1921, p. 375.

STEAM HEATING AND HOT WATER HEATING*

- Capacities of Steam Heating Mains as Affected by Critical Velocities of Steam and Condensate Mixtures
F. C. Houghten and Louis Ebin. TRANSACTIONS, A.S.H.V.E., Vol. 28, 1922, p. 289.
- Capacities of Steam Heating Risers as Affected by Critical Velocity of Steam and Condensate Mixtures
F. C. Houghten and Louis Ebin. TRANSACTIONS, A.S.H.V.E., Vol. 29, 1923, p. 109.
- Critical Velocity of Steam and Condensate Mixtures in Horizontal, Vertical and Inclined Pipes
F. C. Houghten, Louis Ebin and R. L. Lincoln. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 139.
- Flow of Steam and Condensation as Affected by High Pressures, Horizontal Offsets and Valves
Louis Ebin and R. L. Lincoln. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 323.
- Progress Report of the Critical Velocity of Steam Flow in Two-Pipe System
Reported by Margaret Ingels for Louis Ebin and G. H. Eisenhart. TRANSACTIONS, A.S.H.V.E., Vol. 31, 1925, p. 135.
- Capacity of Up-Feed Steam Heating Risers for One and Two-Pipe Systems
F. C. Houghten and M. E. O'Connell. TRANSACTIONS, A.S.H.V.E., Vol. 33, 1927, p. 289.
- Capacity of Radiator Supply Branches for One and Two-Pipe Systems
F. C. Houghten, M. E. O'Connell and Carl Gutberlet. TRANSACTIONS, A.S.H.V.E., Vol. 35, 1929, p. 399.
- Capacity of Return Risers for Steam and Vapor Heating Systems
F. C. Houghten and Carl Gutberlet. JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), October, 1930, p. 859.
- Capacity of Dry Return Mains for Steam and Vapor Heating Systems
F. C. Houghten and Carl Gutberlet. JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), August, 1930, p. 687.

SYNTHETIC AIR CHART

- Modus Operandi of the Synthetic Air Chart
John R. Allen. TRANSACTIONS, A.S.H.V.E., Vol. 26, 1920, p. 545.

TEMPERATURE, HUMIDITY AND AIR MOTION

Effective Temperatures*

- Determining Lines of Equal Comfort
F. C. Houghten and C. P. Yagloglou. TRANSACTIONS, A.S.H.V.E., Vol. 29, 1923, p. 361.
- Determination of the Comfort Zone with Further Verification of Effective Temperatures Within This Zone
F. C. Houghten and C. P. Yagloglou. TRANSACTIONS, A.S.H.V.E., Vol. 29, 1923, p. 361.
- Cooling Effect on Human Beings by Various Air Velocities
F. C. Houghten and C. P. Yagloglou. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 193.
- Effective Temperature Applied to Industrial Ventilation Problems
C. P. Yagloglou and W. E. Miller. TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 339.

*See additional papers on this subject listed in Publications of A.S.H.V.E. Research Laboratory and Cooperating Institutions.

Effective Temperature with Clothing

C. P. Yagloglou and W. E. Miller. *TRANSACTIONS, A.S.H.V.E.*, Vol. 31, 1925, p. 89.

Effective Temperature of Persons Lightly Clothed and Working in Still Air

F. C. Houghten, W. W. Teague and W. E. Miller. *TRANSACTIONS, A.S.H.V.E.*, Vol. 32, 1926, p. 315.

Practical Application of Temperature, Humidity and Air Motion Data to Air Conditioning Problems

F. C. Houghten, W. W. Teague and W. E. Miller. *TRANSACTIONS, A.S.H.V.E.*, Vol. 33, 1927, p. 151.

The Comfort Zone for Men at Rest and Stripped to the Waist

C. P. Yagloglou. *TRANSACTIONS, A.S.H.V.E.*, Vol. 33, 1927, p. 165.

Body Temperature Regulation and Other Physiological Reactions in Their Relation to the Physical Characteristics of Man's Atmospheric Environment

F. C. Houghten and W. W. Teague. *JOURNAL, A.S.H.V.E.*, December, 1928, p. 873.

Heat and Moisture Losses from the Human Body and Their Relation to Air Conditioning Problems

F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant. *TRANSACTIONS, A.S.H.V.E.*, Vol. 35, 1929, p. 245.

Heat and Moisture Losses from Men at Work and Application to Air Conditioning Problems

F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant. *JOURNAL, A.S.H.V.E. (Heating, Piping and Air Conditioning)*, June, 1931, p. 493.

Thermal Exchanges Between the Bodies of Men Working and the Atmospheric Environment

F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant. *American Journal of Hygiene*, Vol. XIII, No. 2, March, 1931, pp. 415-431.

Physiological Reactions

The Relation of Wet Bulb Temperature to Health

O. W. Armspach. *TRANSACTIONS, A.S.H.V.E.*, Vol. 26, 1920, p. 524.

Temperature, Humidity and Air Motion Effects in Ventilation

O. W. Armspach and Margaret Ingels. *TRANSACTIONS, A.S.H.V.E.*, Vol. 28, 1922, p. 103.

Body Temperatures and Their Measurements

W. J. McConnell and F. C. Houghten. *TRANSACTIONS, A.S.H.V.E.*, Vol. 28, 1922, p. 211.

Some Physiological Reactions to High Temperatures and Humidities

W. J. McConnell and F. C. Houghten. *TRANSACTIONS, A.S.H.V.E.*, Vol. 29, 1923, p. 122.

Further Study of Physiological Reactions

W. J. McConnell, F. C. Houghten and F. M. Phillips. *TRANSACTIONS, A.S.H.V.E.*, Vol. 29, 1923, p. 353.

Air Motion, High Temperatures and Various Humidities Reactions on Human Beings

W. J. McConnell, F. C. Houghten and C. P. Yagloglou. *TRANSACTIONS, A.S.H.V.E.*, Vol. 30, 1924, p. 167.

Correlation of Skin Temperature to Physiological Reactions

W. J. McConnell and C. P. Yagloglou. *TRANSACTIONS, A.S.H.V.E.*, Vol. 30, 1924, p. 305.

Work Tests Conducted in Atmospheres of High Temperatures and Various Humidities in Still and Moving Air

W. J. McConnell and C. P. Yagloglou. *TRANSACTIONS, A.S.H.V.E.*, Vol. 31, 1925, p. 101.

Basal Metabolism Before and After Exposure to High Temperatures and Various Humidities

W. J. McConnell, C. P. Yagloglou and W. Fulton. *TRANSACTIONS, A.S.H.V.E.*, Vol. 31, 1925, p. 123.

Heat Given Up by the Human Body and Its Effect on Heating and Ventilating Problems

C. P. Yagloglou. *TRANSACTIONS, A.S.H.V.E.*, Vol. 30, 1924, p. 365.

Thermal Exchanges Between the Human Body and Its Atmospheric Environment

F. C. Houghten, W. W. Teague, W. E. Miller and W. P. Yant. *The American Journal of Physiology*, Vol. 88, No. 3, April, 1929.

Publications of A.S.H.V.E. and Cooperating Institutions

BOILERS*

The Testing of Low Pressure Steam Heating Boilers

L. S. O'Bannon. (University of Kentucky Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 34, 1928, p. 209.

(Also see OIL BURNERS).

DUST

A Study of Dust Determinators

Frank B. Rowley and John Beal. (University of Minnesota Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 34, 1928, p. 475.

Determining the Quantity of Dust in Air by Impingement

Frank B. Rowley and John Beal. (University of Minnesota Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 35, 1929, p. 483.

*See additional papers on this subject listed in Publications of A.S.H.V.E. Research Laboratory and U. S. Bureau of Mines.

HEAT TRANSMISSION

Heat Transmission Research

F. B. Rowley, F. M. Morris and A. B. Algren. (University of Minnesota Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 34, 1928, p. 439.

Thermal Resistance of Air Spaces

F. B. Rowley and A. B. Algren. (University of Minnesota Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 35, 1929, p. 165.

Over-all Heat Transmission Coefficients Obtained by Tests and by Calculation

F. B. Rowley, A. B. Algren and J. L. Blackshaw. (University of Minnesota Cooperating). *TRANSACTIONS, A.S.H.V.E.*, Vol. 35, 1929, p. 443.

Effects of Air Velocities on Surface Coefficients

F. B. Rowley, A. B. Algren and J. L. Blackshaw. (University of Minnesota Cooperating). *JOURNAL, A.S.H.V.E. (Heating, Piping and Air Conditioning)*, December, 1929, p. 673.

Surface Conductances as Affected by Air Velocity, Temperature and Character of Surface

F. B. Rowley, A. B. Algren and J. L. Blackshaw. (University of Minnesota Cooperating), JOURNAL, A.S.H.V.E., (*Heating, Piping and Air Conditioning*), June, 1930, p. 501.

HEATERS

Heat and Air Volume Output of Unit Heaters

L. S. O'Bannon. (University of Kentucky Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 35, 1929, p. 457.

Suggested Method of Testing Unit Heaters Suitable for Field Use

L. S. O'Bannon. (University of Kentucky Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), February, 1930, p. 153.

INFILTRATION

Effect of Frame Calking and Storm Windows on Infiltration Around and Through Windows

W. M. Richtmann and C. Braatz. (University of Wisconsin Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 34, 1928, p. 547.

Air Infiltration Through Various Types of Brick Wall Construction

G. L. Larson, C. Braatz and D. W. Nelson. (University of Wisconsin Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 35, 1929, p. 183.

Air Infiltration Through Various Types of Brick Wall Construction

G. L. Larson, D. W. Nelson and C. Braatz. (University of Wisconsin Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), November, 1929, p. 585.

Air Infiltration Through Various Types of Wood Frame Construction

G. L. Larson, D. W. Nelson and C. Braatz. (University of Wisconsin Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), June, 1930, p. 509.

Infiltration Through Double Hung Wood Windows

G. L. Larson, D. W. Nelson and R. W. Kubasta. (University of Wisconsin Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), July, 1931, p. 583.

OIL BURNERS

Effect of Oil Burner Adjustments on Over-all Boiler Efficiency and a Progress Report on Research

L. E. Seeley. (Yale University and American Oil Burner Association Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), May, 1930, p. 423.

Study of Performance Characteristics of Oil Burners and Low Pressure Heating Boilers

L. E. Seeley and E. J. Tavanlar. (Yale University and American Oil Burner Association Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), May, 1931, p. 419.

RADIATION

Steam Condensation. An Inverse Index of Heating Effects

A. P. Kratz and M. K. Fahnestock. (University of Illinois Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), July, 1931, p. 621.

STEAM AND HOT WATER HEATING

Simultaneous Flow of Water and Air in Pipes

L. S. O'Bannon. (University of Kentucky Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 30, 1924, p. 157.

Pipe Sizes for Hot Water Heating Systems

F. E. Giesecke and Elmer G. Smith. (Texas Engineering Experiment Station, Texas Agricultural and Mechanical College, Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 35, 1929, p. 419.

Pipe and Orifice Sizes for Small Gravity Circulation Hot Water Heating Systems

Elmer G. Smith. (Texas Engineering Experiment Station, Texas Agricultural and Mechanical College, Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), February, 1930, p. 135.

Loss of Head in Submerged Orifices

F. E. Giesecke. (Texas Engineering Experiment Station, Texas Agricultural and Mechanical College Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), July, 1930, p. 611.

Friction Heads in One Inch Standard Cast-Iron Tees

F. E. Giesecke and W. H. Badgett. (Texas Engineering Experiment Station, Texas Agricultural and Mechanical College, Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), May, 1931, p. 430.

Sizing Pipes and Orifices for Gravity Hot Water Heating Systems

Elmer G. Smith. (Texas Engineering Experiment Station, Texas Agricultural and Mechanical College Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), July, 1931, p. 603.

MEASUREMENT OF AIR DELIVERY

The Measurement of the Flow of Air Through Registers and Grilles

Lynn E. Davis. (Armour Institute of Technology and Ventilating Contractors Employers Association of Chicago Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), January, 1930, p. 57.

The Measurement of the Flow of Air Through Registers and Grilles, Part II

Lynn E. Davis. (Armour Institute of Technology and Ventilating Contractors Employers Association of Chicago Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), April, 1931, p. 325.

GARAGE VENTILATION

Carbon Monoxide Concentration in Garages

A. S. Langsdorf and R. R. Tucker. (Washington University, St. Louis, Cooperating), JOURNAL, A.S.H.V.E. (*Heating, Piping and Air Conditioning*), August, 1930, p. 695.

TEMPERATURE, HUMIDITY AND AIR MOTION

The Summer Comfort Zone: Climate and Clothing

C. P. Yagloglou and Philip Drinker. (Harvard School of Public Health Cooperating), TRANSACTIONS, A.S.H.V.E., Vol. 35, 1929, p. 269.

COMMITTEE ON RESEARCH 1931

C. V. HAYNES, CHAIRMAN

F. B. HOWELL, VICE-CHAIRMAN

PROF. A. C. WILLARD, TECHNICAL ADVISER

THREE YEARS

C. A. BOOTH
F. B. HOWELL
WALTER KLINE
F. B. ROWLEY
J. H. WALKER

TWO YEARS

C. V. HAYNES
W. T. JONES
J. F. MCINTIRE
F. N. SPELLER
PERRY WEST

ONE YEAR

O. W. ARMSPACH
R. S. FRANKLIN
F. E. GIESECKE
A. P. KRATZ
A. E. STACEY

G. P. HOOD, EX-OFFICIO

F. C. HOUGHTEN, DIRECTOR

